



**Are High-Value Agri-food Supply Chains Participants Better Insulated from Shocks? Evidence from Senegal**

Senakpon Fidele Ange Dedehouanou  
(University of Abomey Calavi, Benin)  
dsenakpon@gmail.com

Paper prepared for the IARIW-TNBS Conference on “Measuring Income, Wealth and Well-being in Africa”, Arusha, Tanzania November 11-13, 2022

Concurrent Session 6A: Agriculture

Time: Saturday, November 12, 2022 [10:30 AM -12:00 PM]

# **Are high value agri-food supply chains participants better insulated from shocks? Evidence from Senegal**

Sènakpon F. A. DEDEHOUANOU

University of Abomey Calavi (UAC)/FASEG, Benin

## **Abstract**

Empirical studies in general show that the participation in high value agri-food supply chains has positive impacts on household wealth, income and poverty reduction. Other more qualitative studies, however, point to potential adverse effects, such as increased vulnerability of participants. In this paper we use an endogenous switching regression model to examine the extent to which households involved in high value agri-food supply chains insure their consumption against income fluctuations in Senegal. We find that contract farming households are not able to better insure their total and food consumption against changes in (farm) income. In contrast, households which are involved in the high value supply chain through the labour market are effectively able to better insure themselves. This result draws the attention to not focus only on poverty reduction issues when studying the welfare implication of rural households participating in the high value agri-food supply chains.

**Keywords:** Consumption insurance; Supply chains; Smallholder farming; Senegal

**JEL codes:** D1, R2, O16

## 1. Introduction

As in many sub-Saharan African countries, agriculture is the main activity in rural Senegal. About half of the active population is involved in this activity which has long been the engine of economic and social development of the country. In most rural agricultural areas in developing countries, low incomes or the lack of an income source is seen as the cause of poverty precariousness. In this regard, Senegal has undertaken a strategy of diversification toward high value commodities and the promotion of agricultural export products to integrate international agricultural markets.

This strategy is concomitant with the changes observed in international food markets during the last two decades. Mainly in the fresh fruit and vegetable (FFV) sectors, the transformation includes a shift from traditional tropical exports to non-traditional high value exports from developing countries. It also includes the increased importance of food quality and safety standards; the increasing consolidation of the agri-food chain with large retail chains and food multinationals gaining importance; and the increased industrialization of the agriculture sector (see Swinnen, 2007). The resulting modern agri-food supply chains have changed the agri-food systems in developing countries like Senegal (e.g., Swinnen, 2007; Henson and Jaffee, 2008). Two important aspects of the development of modern agri-food supply chains in Senegal are the increasing of non-traditional high value exports to developed countries and agro-industry employment opportunities for small-scale farmers (Maertens and Swinnen, 2009). Some farmers, through contracts with exporting agro-industry companies, cultivate green beans or mangoes—some high value products mainly intended for the international export market. Several farmers are also involved in the non-skilled wage employment from these agro-industry companies<sup>1</sup>.

An important and ongoing question raised in the literature concerns the welfare implications of the integration of developing countries in the global market, particularly how the structural changes in international food markets affect rural households participating in the high value agri-food supply chains that evolved. Optimistic arguments advance that contract farming with large agro-industries alleviate the constraints faced by small-scale farmers (Warning and Key, 2002). They also stress the new employment opportunities for rural households (Key and Runsten, 1999). Studies provide empirical evidence that most of the FFV exports from Madagascar (Minten et al., 2009) and Kenya (Minot and Ngigi, 2004) stem from contract farming with small-scale

farmers. Other studies show that despite increasing standards, the vegetable export chain in Senegal can benefit small-scale farmers and rural households either through contract farming from large-scale estate production or through employment from agro-industrial processing (Maertens, 2009; Maertens and Swinnen, 2009).

Nevertheless, many other studies remain sceptical while considering as new trade barriers the stringent food standards and vertical coordination which has resulted (Unnevehr, 2000; Brenton and Manchin, 2002; Augier et al., 2005). Some indicate that small-scale farmers are more and more excluded from the high value commodities chain (Kherallah, 2000; Reardon and Barrett, 2000; Gibbon, 2003). In addition, other authors argue that even if they participate, the revenue gain resulting from this trade is likely to be small for resource-poor farmers (Reardon et al., 1999; Dolan and Humphrey, 2000). Others point to potential adverse effects such as increased vulnerability of participants (e.g., Porter and Phillips-Howard, 1997; Key and Runsten, 1999).

In this paper we propose an alternative and complementary framework to study the welfare implication of rural households participating in the high value agri-food supply chains in Senegal. Previous quantitative analyses focusing on income report positive impact from the participation in the supply chains. Qualitative analyses highlight negative impacts as well yet both types of results are worth considering within the same framework. Household welfare depends on income as well as on other factors. Moreover, agriculture per se is itself considered as a risky activity rendering the income unstable. The welfare of rural households does not depend on the income level, but is also likely to be subject to income fluctuations.

We build on the literature on consumption insurance<sup>2</sup> and go beyond the measure of income and poverty used by previous studies to analyse the welfare implication of rural households participating in the high value agri-food supply chains. To the best of our knowledge we are not aware of a study in the literature of supply chains that considers the framework on consumption insurance to analyse this issue. The development of agri-food supply chains that was emerging in Senegal has reshaped smallholder livelihood strategies. We ask whether households involved in the high value supply chains are able to better insure their consumption against shocks defined as income fluctuations. More specifically, we analyse whether the consumption of the supply-chain participants is better insured against income fluctuations than the consumption of their non-

participating counterparts. We Also analyse what segment of the market (production market or labour market) makes households less vulnerable.

The literature on vulnerability assessment underlines the household sense of well-being within the framework of poverty eradication and risky environment. Households face uncertainty about the future which stems from various sources of risks or shocks. This plays a central role in the dynamic and scale of poverty (Chaudhuri, 2003). Moreover, Murata and Miyazaki (2014) found that diversification is a way to reduce risk exposure. It is thus desirable to analyse the welfare implications of the integration of rural households in the global market—through high value supply chains—by considering a measure of household welfare which takes into account both average outcomes and the risk households bear (Ligon and Schechter, 2003). The cross section data (one year) used by most of the previous literature that focused mainly on the income-based measure of welfare is thus limited to dealing with the issue of household’s vulnerability and the dynamic of the agri-food supply chain sector.

The remainder of the paper is structured as follows. The next section discusses a conceptual framework on consumption insurance. In section three, we describe our case study and the data. Section four presents some descriptive statistics. In section five we propose an empirical methodology to test the consumption insurance hypothesis. Results and discussions are presented in Section six. Section seven concludes.

## 2. Conceptual framework

We rely on the framework of consumption insurance widely used in the literature (Altonji and Siow, 1987; Mace, 1991; Townsend, 1994). The theoretical model is based on the consumer’s optimization problem that supposes a specific preference for a given household (see e.g., Cochrane, 1991). Irrespective of the consumption smoothing mechanisms used, households are supposed to maximize their expected utility function subject to the expected value budget constraint. The complete consumption insurance equation that is derived after the optimization problem is summarized in a logarithmic form as:

$$\Delta \ln c_t^h = \rho^{-1} \Delta f(z_t) - \rho^{-1} \Delta \ln \mu_t \quad (1)$$

where  $c_t$  is household consumption in time  $t$ ;  $\rho$  is the coefficient of constant absolute risk aversion;  $f(z_t)$  is a function denoting the influence of time-varying taste factors  $\Delta \ln c_t^h = \ln c_t^h - \ln c_{t-1}^h$ ; and  $\mu_t$  is the time-specific component of the marginal utility of consumption in time  $t$ . Through Equation 1, the complete consumption insurance hypothesis states that the growth rate in household consumption is a function only of the growth rate in the aggregate or covariate risk ( $-\rho^{-1} \Delta \ln \mu_t$ ), after controlling for the influence of the time-varying taste factors.

Different testable empirical forms of the consumption insurance model have been used for many purposes in developing countries. While naturally consumption is used as the dependent variable, the empirical specifications derived from Equation 1 depend on the variables used in the right hand side. In any case, the specification takes the general form (see e.g., Skoufias and Quisumbing, 2005):

$$\Delta \ln c_{tg}^h = \alpha Covrisk_{tg} + \beta Idiorisk_{tg}^h + \lambda X_{tg}^h + \Delta \varepsilon_{tg}^h \quad (2)$$

where  $\Delta \ln c_{tg}^h$  refers to the change in log consumption (or growth rate) per household  $h$  member, in period  $t$ , in a given insurance community group  $g$ ;  $Covrisk_{tg}$  indicates the aggregate or covariate risks common to all households within the community group  $g$ ; and  $Idiorisk_{tg}^h$  represents the idiosyncratic risks affecting the household. The vector  $X_{tg}^h$  controls for some household characteristics (or changes in) and  $\Delta \varepsilon_{tg}^h$  for unobservable changes in household specific characteristic such as household preferences.

The test of full consumption insurance derived from the empirical form implies that the coefficient  $\beta$  tends to zero, that is, the idiosyncratic risks should not play any significant role in explaining changes in household consumption. In the literature, the difference in the specifications often stems from the variables used for the representative idiosyncratic shocks against which household consumption should be insured and also from the identified insurance group. Some empirical forms (e.g., Skoufias and Quisumbing, 2005) include directly, when available, variables representing the shocks ( $S_i$ ) that can affect income so that  $\beta Idiorisk_{tg}^h = \sum_i \beta_i S(i)_{tg}^h$ . Others (e.g., Morduch, 2002) include idiosyncratic income changes so that  $\beta Idiorisk_{tg}^h = \beta \Delta \ln y_{tg}^h$ , where  $y$

represents household income per capita. With regard to the covariate risk, most studies usually use village or community as the insurance group (e.g., Jalan and Ravallion, 1999). In that case the term  $\alpha Covrisk_{tg}$  in Equation 2 is replaced by a set of binary interaction terms identifying communities or villages by survey rounds. However, some studies focus on an insurance network limited to member of family, friends or ethnicity (e.g., Fafchamps and Lund, 2003; De Weerd and Dercon, 2006).

This paper does not limit the insurance network to family member, friends or ethnicity. While the consumption insurance framework primary seeks whether or not full consumption insurance takes place as revealed in the data used, we aim to analyse how different is consumption insurance between participants in agri-food supply chains and non-participants. This type of comparative analysis has been used in others studies. For example, Skoufias (2007) examines how the replacement of pre-existing subsidy programmes by a conditional cash transfer programme affects the consumption insurance of households in rural Mexico. Working on two villages in northern Bangladesh, Amin et al. (2003) tested if members of microcredit programmes are poorer and more vulnerable than non-members. They define as vulnerable households those which are unable to smooth consumption in the face of idiosyncratic income fluctuations.

In this paper we use the village as an insurance community where formal or informal insurance arrangements are potentially available for households. The extent to which households insure consumption from shocks or income fluctuations depends on their ability to cope with the risks. Given that household decisions on income generating activities are related to risk considerations (Dercon, 1996; Reardon et al., 2007; Lanjouw, 2007), it is likely differences be observed in the coefficient  $\beta$  between groups of households within the insurance village. Particularly in the case of agri-food supply chains, we expect that differences between households participating in the supply chains and those which are not participants. The involvement in the high value supply chains, either through the export production by contract farming or through the labour market by working as an agro-industry employee, is a way to reduce poverty, as found in previous studies. Three important aspects are noted from Maertens (2009) and Maertens and Swinnen (2009) who focused on the same area as our research). First, both types of households are different in terms of some demographic characteristics, wealth and income. Second, income

from the supply chains is a non-negligible component of total household income for participants. Third, poverty is much higher among non-participants than among participants.

### **3. Data**

We use two rounds of household surveys conducted in the region of “*les Niayes*” in Senegal, in July–August 2007 and in July–August 2010. The surveys took place in a horticulture zone around the regions of Dakar and Thiès. Most (80%) of the horticultural production of the country stems from this zone (RFAU/AOC, 2007); this is where most of the export companies source produce from and recruit labourers. The surveys collected data on 40 villages randomly selected in 4 rural communities. A total of 455 households were initially randomly selected in the first round of the survey, but some observations were dropped due to attrition between the two rounds and missing values in the variables of interest. The sample we use consists of a balanced panel of 439 households in the 2 years 2007 and 2010<sup>3</sup>.

Data on household demographic characteristics and on different types of household activities that allow calculating household income were collected. Most households in this area practise smallholder horticulture farming and hence derive their income from agricultural activities. However, household income is also supplemented with non-negligible revenues from off-farm activities. We use this detailed information on farm and off-farm activities to calculate total household income and its components, namely farm and off-farm income. Total household income is income calculated over the 12 months prior to the survey from farming, from employment (agro-industrial or others), from other non-farm business activities (self-employment), and from remittances (non-labour). Income from farming is calculated as revenue from sale of produce, plus the imputed value of unsold produce, less the costs of production.

The surveys also collected information on household expenditure. Different modules were included in the questionnaires to collect data on the expenses of households on food and non-food items. The recall periods for items are set to be more disaggregated to get as much as possible reliable information on the expenses. Daily or weekly information was requested for some basic food such as bread, vegetables and other foods. The recall periods were more extended to (the last) one, two or three months prior to the surveys for non-food items such as water, electricity, combustibles, clothing expenses and the like and to the 12 last months prior to before the surveys



for expenses related to health, schooling, etc. Non-food items do not include expenses in durable goods. All consumption expenses were converted to have a yearly basis.

An additional module was added in the 2010 survey round that asked questions related to the shocks experienced by the households during the past three years, that is, from the first 2007 round to the last 2010 round (see Figure A1 in Appendix). These data were used to describe the vulnerability context of the study area.

#### **4. Household livelihoods and shocks**

This section provides descriptive statistics on household assets and the vulnerability context that might influence household livelihood strategies and livelihood outcomes.

##### *4.1. Defining high value agri-food supply chains participants*

We define two types of participants. The first are contracting households: households that exclusively differentiated towards high value produce mainly for the export market—through contract with agro-industry companies—at least once in the two rounds of surveys. About a third (33.72%) of households of this type in our sample grew green bean and mangoes—either in 2007, in 2010 or in both years—mainly for the export market through contract with agro-industry companies. The second category of households is defined as agro-industry employee households. These are households that had one or more members working as employees in an agro-industrial export firm either in 2007, in 2010 or in both years. Of the households in the sample, 20.41% were in this category<sup>4</sup>. Households that are not included in any type of participants as defined above were considered as not participating in the agri-food supply chains in the two rounds of surveys.

##### *4.2. Size and importance of household livelihood assets*

Participants — contracting and agro-employees—and non-participants households differ according to the type of assets. We calculate the average amount of human, physical and social capital of households over the period 2007–2010 and compare these values between different types of households as defined above (Table 1). Contracting and agro-industrial employees have relatively higher livelihood assets. Significant differences are observed in some cases. Agro-industrial employees have at their disposal a significantly higher number of workers, fewer

dependents and more women as head of household. Contracting households are slightly older with significantly higher education. They also have significantly higher access to larger land (5.10 ha and 0.69 ha per capita) and to more livestock (3.36 units). Agro-industrial employees have access to less physical capital of this kind compared to non-participants households. Both contracting and agro-industrial employees live in slightly smaller housing area than non-participants households and could rely on a significantly higher social capital such as their ethnicity or the farmer organization they belong to.

**Table 1: Household characteristics: Comparison of mean values between participants and non-participants**

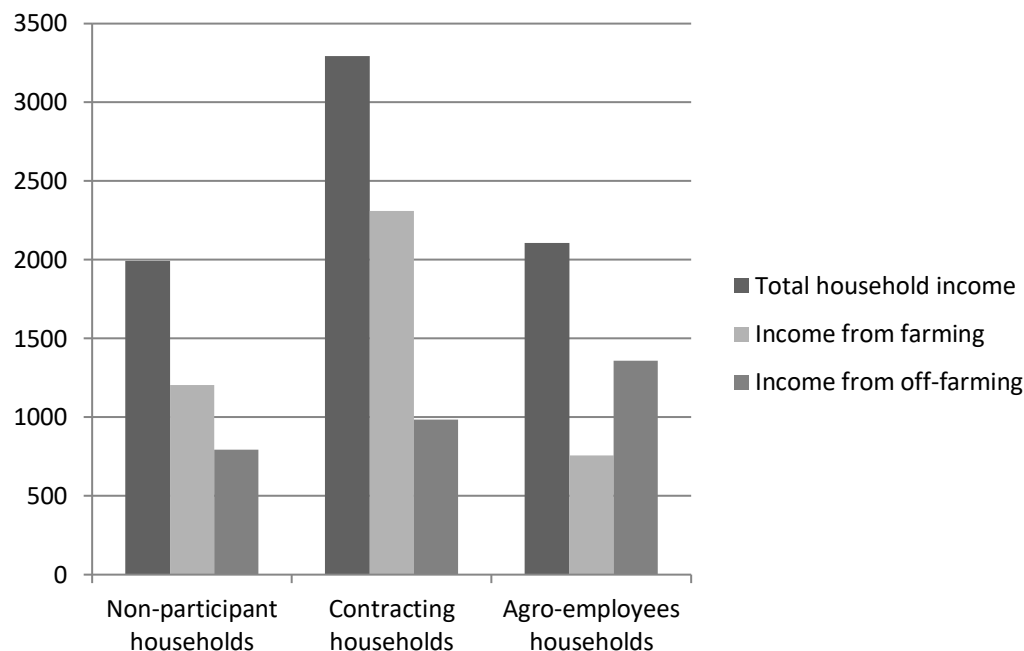
|   | Total pooled sample | Non-participant households | Contracting households |     | Agro-industrial employees |
|---|---------------------|----------------------------|------------------------|-----|---------------------------|
| Number of households  | 338                 | 155                        | 114                    |     | 69                        |
| <i>Human capital</i>  |                     |                            |                        |     |                           |
| Age of household head   | 55.06               | 54.93                      | 55.48                  |     | 54.67                     |
| Number of labourers   | 9.02                | 8.49                       | 8.98                   |     | 10.27 ***                 |
| Dependency ratio  | 0.63                | 0.67                       | 0.68                   |     | 0.48 ***                  |
| Female-headed household (%)   | 6.51                | 5.81                       | 6.14                   |     | 8.70                      |
| Years of education of household head  | 1.34                | 1.05                       | 1.66                   | *   | 1.49                      |
| <i>Physical capital</i>   |                     |                            |                        |     |                           |
| Farm size (ha)  | 3.53                | 2.84                       | 5.10                   | *** | 2.45                      |
| Per capita landholdings (ha)  | 0.47                | 0.39                       | 0.69                   | *** | 0.30 **                   |
| Units of livestock  | 2.64                | 2.50                       | 3.36                   |     | 1.76                      |
| Housing surface (m <sup>2</sup> )   | 218.35              | 239.25                     | 201.23                 |     | 199.69                    |
| <i>Social capital</i>   |                     |                            |                        |     |                           |
| Ethnicity (Wolof household) (%)   | 63.31               | 56.77                      | 63.16                  |     | 78.26 ***                 |
| Membership of a farmer organization (%)   | 86.98               | 82.58                      | 93.86                  | *** | 85.51                     |
| <i>Shocks experienced between 2007 and 2010</i>   |                     |                            |                        |     |                           |
| Severe drop in agricultural production due to rain, flood, pests or disease affecting crops (%) | 39                  | 35                         | 49                     | *** | 31                        |
| Destruction of housing or loss of items due to flood or fire (%)                                | 2                   | 2                          | 2                      |     | 4                         |
| Divorce or separation (%)   | 6                   | 5                          | 6                      |     | 7                         |
| Death of a household member (%)   | 20                  | 24                         | 19                     |     | 13 **                     |
| Drastic increase in product prices bought by the household (%)                                  | 70                  | 70                         | 75                     |     | 60 *                      |

|   |    |    |     |     |
|---|----|----|-----|-----|
| Disease or death affecting livestock (%)                        | 22 | 20 | 26  | 21  |
| Illness or injury of a household member more than two weeks (%) | 44 | 45 | 45  | 42  |
| Loss of a paid employment (%)                                   | 2  | 4  | 1 * | 1 * |
| Loss or theft items valued more than 5,000 FCFA (%)             | 12 | 11 | 13  | 14  |

Source: Calculated from household survey data.

Our conclusion on the comparison of physical and social capital between participants and non-participants is close to that of Maertens and Swinnen (2009) that used information limited to the 2005 sample. Our slightly different results on human capital may be due to the inclusion of additional households in the 2007 and 2010 samples. Nevertheless, the general trend observed concerning the livelihood assets of households was that while agro-industrial employees are relatively better off in terms of human and social capital, contracting households have more access to physical and social capital. Compared to non-participants households, this is in line with the general view that communities or households with a relatively high level of financial capital are also likely to have control over more livelihood assets, notably human and physical capital. Both contracting households and agro-industrial employees have average total incomes over 2007 and 2010 that are higher than those of non-participants households (Figure 1). Incomes from off-farming activities—that necessitate more active labour—are relatively high for participants in agro-industrial employment who have more access to human capital. Likewise, as depicted in Figure 1, incomes derived from farming activities—that require more farm input—are relatively high for contracting households which have more access to physical capital.

**Figure 1: Average household income over 2007 and 2010 (in 1000 FCFA)**



Source: Calculated from household survey data.

Taking into account these conclusions, at first sight, consumption insurance is expected to be relatively higher for participants as they are more likely to have access to the means of or mechanisms for dealing with shocks. Indeed, some studies have found that consumption insurance depends on occupation and that richer residents are better insured in their consumption (see, e.g., Townsend, 1995; Jalan and Ravallion, 1999).

#### 4.3. Shocks and household consumption expenditures

This section portrays the vulnerability context that characterizes the area and the period of study. During the survey conducted in July–August 2010, we asked households some information about the last year between 2007 and 2010 they experienced any specific shocks and whether these shocks had led to a drop of income and consumption. Some descriptive evidence on the extent and the severity of shocks is presented in Table 2. First, households in the study area have faced different types of shocks, some more than others. According to the number of households reporting these shocks, the most important ones are related to the increasing of product prices, illness, the drop in agricultural production, livestock disease and affective shocks. Shocks related to agricultural production hit significantly more contracting households. Affective shocks hit

significantly fewer agro-industrial employees. . Most of the shocks tend relatively to hit all types of households, participants as well as non-participants (see Table 1). This is particularly true for the drastic increase in product prices bought by households: at least 60% of households of any type reported being affected by that shock which was probably induced by the world food prices crisis that occurred during the period of our study.

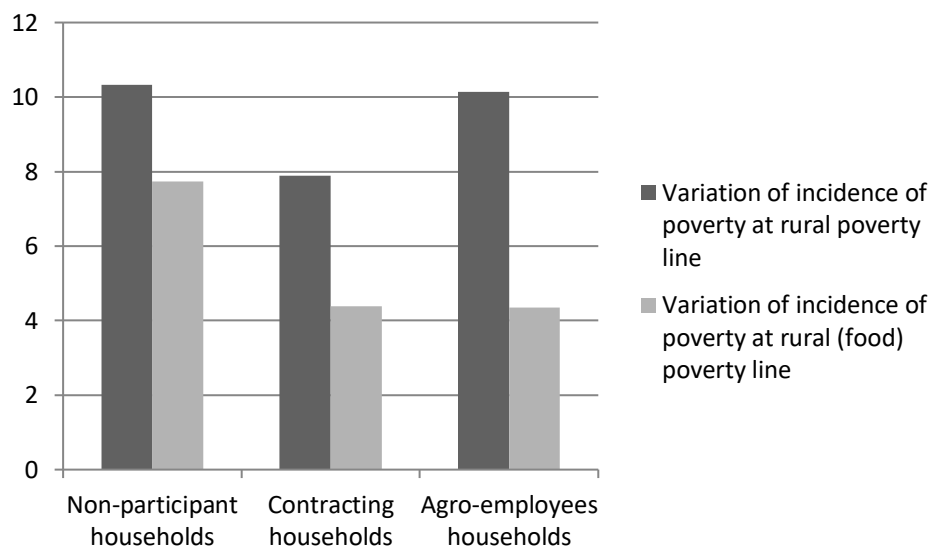
**Table 2: Extent and severity of shocks experienced by households between 2007 and 2010**

| Type of shocks   | Households reporting this shock | Shock affecting     |                                 |                                | Shock leading to                 |                |                               |
|--|---------------------------------|---------------------|---------------------------------|--------------------------------|----------------------------------|----------------|-------------------------------|
|  |                                 | Only this household | Some households in this village | All households in this village | All households in this community | Drop in income | Reduction in food consumption |
| Severe drop in agricultural production due to rain, flood, pets or disease affecting crops | 181                             | 1.65                | 86.76                           | 11.59                          | 0                                | 81.22          | 35.36                         |
| Destruction of housing or loss of items due to flood or fire                               | 10                              | 60                  | 40                              | 0                              | 0                                | 60             | 20                            |
| Divorce or separation  | 29                              | 48.3                | 51.7                            | 0                              | 0                                | 10.34          | 3.45                          |
| Death of a household member  | 91                              | 12.1                | 87.9                            | 0                              | 0                                | 48.35          | 24.18                         |
| Drastic increase in product prices bought by the household                                 | 315                             | 0.32                | 66.68                           | 33                             | 0                                | 60.63          | 32.7                          |
| Disease or death affecting livestock   | 107                             | 3.72                | 96.28                           | 0                              | 0                                | 47.66          | 8.41                          |
| Illness or injury of a household member more than two weeks                                | 197                             | 2.55                | 93.9                            | 3.55                           | 0                                | 60.41          | 24.37                         |
| Loss of a paid employment  | 20                              | 40                  | 60                              | 0                              | 0                                | 50             | 5                             |
| Loss or theft items valued more than FCFA5,000   | 59                              | 15.21               | 84.79                           | 0                              | 0                                | 49.15          | 11.86                         |

Source: Calculated from household survey data.

Second, the shocks experienced by the households are relatively idiosyncratic. Neither all the villages in the rural community nor all households in all the villages included in our sample were affected by these shocks. Agricultural production shock, food prices shock and illness shocks take a form of aggregate shocks in some villages as 12%, 33% and 4% respectively of all villages included in our sample had all households that were hit by these shocks (Table 2). Third, household incomes are more subject to specific shocks and this is for any type of shocks. More than 50% of the households reported a fall in income resulting from shocks, a percentage far higher than that reported for a drop in food consumption.

**Figure 2: Percentage of households in 2007 remaining or falling into poverty in 2010**



Source: Calculated from household survey data.

The statistics in Table 2 suggest that some households were more resilient to shocks than others. Others were unable to cope with shocks and were even more subject to vulnerability to these shocks. Using household (consumption) expenditures data for 2007 and 2010 as the welfare measure, we calculated the incidence of poverty in the study area for each year, that is, the proportion of households with food and total per capita expenditures that fall below the national rural poverty lines for these years. We then calculated roughly a measure of vulnerability, that is, the proportion of households that were poor or not in 2007 but remaining or falling into poverty in

2010. Figure 2 shows that at least 8% of households remain vulnerable in regard to total expenditures and at least 4% of households in regard to food expenditures. Some differences exist between participants and non-participants: vulnerability is much lower among contracting households and particularly among agro-industrial employees when considered food expenditures.

## 5. Econometric analysis

We used a modified version of the equation (2) to test the consumption insurance for households participating in agri-food supply chains. We account for potential endogeneity problems that may lead to biased regression coefficients. For example, abstracting from the literature on risk management strategy (Rosenzweig and Binswanger, 1993; Jacoby and Skoufias, 1998; Morduch, 1995), difference in consumption smoothing between households may be due to unobserved managerial abilities to cope with risk. These abilities might also be related to their adoption of management strategies such as the likelihood to become involved or not in agri-food supply chains. Furthermore, some sources of selection bias could come from households, from exporting companies and from geographical conditions (see Maertens and Swinnen, 2009)<sup>5</sup>.

We use an endogenous switching regression (ES) model that deals with the selectivity and the endogeneity issue:

$$\Delta \ln c_{hv1} = \alpha_{v1} \overline{\Delta \ln y_{hv}} + \beta_1 \Delta \ln y_{hv} + \delta_1 X_{hv} + \Delta \varepsilon_{hv} \quad \text{if } PART_h = 1 \quad (3)$$

$$\Delta \ln c_{hv0} = \alpha_{v0} \overline{\Delta \ln y_{hv}} + \beta_0 \Delta \ln y_{hv} + \delta_0 X_{hv} + \Delta \varepsilon_{hv} \quad \text{if } PART_h = 0 \quad (4)$$

$$\text{With } PART_h^* = Z'_{hv} \alpha + u_{hv} \quad \text{and } PART_h = \begin{cases} 1 & \text{if } PART_h^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

where  $\Delta \ln c_{hv1}$  and  $\Delta \ln c_{hv0}$  is the change in log consumption (or growth rate) per household  $h$  member, in the village  $v$ ;  $\overline{\Delta \ln y_{hv}}$  is the growth rate in average village income and represents the aggregate or covariate risks common to all households within the village<sup>6</sup>;  $\Delta \ln y_{hv}$  is the growth rate of household income per capita; and  $X_{hv}$  are exogenous control for household (head) characteristics such as the age of the head, whether the head is a female, the education of the head, the ethnicity of the household and the change in family size in the two rounds of surveys.



The variable  $PART_h$  is a dummy variable indicating participation of the household in the agri-food supply chains.  $Z_h$  are the same set of variables included in  $X_h$ , with additional exclusion restrictions to improve identification.

The ES model estimates separately the equations for participant households (3) and for non-participants households (4), conditional on the participation decision modeled in (5)<sup>7</sup>. Equation 5 assumes that households become involved in the high value supply chains when the difference—the latent variable  $PART_h^*$ —between the marginal net benefits of participating and not participating in the supply chains is positive<sup>8</sup>. The ES model is estimated simultaneously by full maximum likelihood. We use as exclusion restrictions either the changes in female labour, or the changes in male labour, or whether the household has an irrigated system or the distance of the exporter firms from the villages. Results of the selection Equation 5 show that these instruments jointly and significantly determine the participation process as most of the export companies source produce from contracting farming and recruit labourers. The instruments are assumed not directly related to the changes in log consumption per capita otherwise than through the participation process. In addition, selection bias and endogeneity are an issue as indicated by the Wald test of independence equations (see Table A1 and Table A2 in Annex)<sup>9</sup>. The extent to which consumption is insured from idiosyncratic income changes for participants and for non-participants is tested through the coefficients  $\beta$ .

## 6. Results and discussion

Table 3 shows that there is a difference in the extent to which participants and non-participants insulate consumption from changes in income (column 1). Changes in household income per capita have no significant effect on changes in total and food consumption for non-participants. In general non-participants seem to be fully insulated from income changes contrary to participants' households. However, column (2) and column (3) show that both types of households are able to insure total and food consumption from changes in farm income while they experience at least a drop of 0.29% of total consumption and 0.22% of food consumption following a 10% drop in off-farm income. How different are these results when we distinguish between contract farming households and agro-industrial employee households? We report in Table 4 and Table 5 the estimates of the degree of consumption insurance for the two different types of participants and for non-participants.

Two observations are noted. First, column 1 of Table 5 shows that there is not significant difference in the extent to which agro-industry employee households and non-participants in the supply chains insulate consumption from shocks. The results suggest that non-participants are fully insulated from income changes as equal as agro-industry employee households. Rather, changes in household income per capita have a significant effect on changes in total and food consumption for contracting households. For that type of participant, a decrease of 10% in income would result in a drop of 0.64% of total consumption and a drop of 0.57% of food consumption (column 1 of Table 4). Second, participants of any kind and non-participants are able to insure total and food consumption from farm income changes (column 2 of Table 4 and Table 5). However, total and food consumption are still subject to household off-farm income changes for both non-participants and households involved in green bean or mango contracts with an export agro-industry (column 3 of Table 4 and Table 5).

**Table 3: Estimates of the impact of changes in household income on changes in consumption: Participants and non-participants households**

|                                   | (1) Changes in total income  |                             | (2) Changes in farm income   |                             | (3) Changes in off-farm income |                             |
|-----------------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|--------------------------------|-----------------------------|
|                                   | Changes in total consumption | Changes in food consumption | Changes in total consumption | Changes in food consumption | Changes in total consumption   | Changes in food consumption |
| $\beta_{\text{non-participants}}$ | 0.003<br>(0.023)             | 0.020<br>(0.024)            | -0.014<br>(0.009)            | -0.009<br>(0.009)           | 0.031**<br>(0.012)             | 0.034***<br>(0.012)         |
| $\beta_{\text{participants}}$     | 0.052**<br>(0.020)           | 0.043**<br>(0.018)          | 0.002<br>(0.009)             | 0.002<br>(0.009)            | 0.029***<br>(0.011)            | 0.022**<br>(0.010)          |

*Note:* Additional controls are included but not reported. See Table A1 in Annex.

Significant effects are indicated with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ . Robust standard errors in parentheses.

Source: Estimated from household survey data.

**Table 4: Estimates of the impact of changes in household income on changes in consumption: Contracting households and non-participants households**

|  | (1) Changes in total income  |                             | (2) Changes in farm income   |                             | (3) Changes in off-farm income |                             |
|--|------------------------------|-----------------------------|------------------------------|-----------------------------|--------------------------------|-----------------------------|
|  | Changes in total consumption | Changes in food consumption | Changes in total consumption | Changes in food consumption | Changes in total consumption   | Changes in food consumption |
| $\beta_{\text{non-participants}}$      | 0.005                        | 0.022                       | -0.017*                      | -0.013                      | 0.035***                       | 0.037***                    |
|  | (0.023)                      | (0.025)                     | (0.010)                      | (0.010)                     | (0.013)                        | (0.012)                     |
| $\beta_{\text{contracting household}}$ | 0.064**                      | 0.057**                     | 0.010                        | 0.010                       | 0.041**                        | 0.034**                     |
|  | (0.027)                      | (0.027)                     | (0.013)                      | (0.013)                     | (0.016)                        | (0.017)                     |

*Note:* Additional controls are included but not reported. See Table A2 in Annex.

Significant effects are indicated with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ . Robust standard errors in parentheses.

Source: Estimated from household survey data.

**Table 5: Estimates of the impact of changes in household income on changes in consumption: Agro-industry employees households and non-participants households**

|  | (1) Changes in total income  |                             | (2) Changes in farm income   |                             | (3) Changes in off-farm income |                             |
|--|------------------------------|-----------------------------|------------------------------|-----------------------------|--------------------------------|-----------------------------|
|  | Changes in total consumption | Changes in food consumption | Changes in total consumption | Changes in food consumption | Changes in total consumption   | Changes in food consumption |
| $\beta_{\text{non-participants}}$                  | 0.002                        | 0.021                       | -0.010                       | -0.005                      | 0.027**                        | 0.031***                    |
|  | (0.022)                      | (0.022)                     | (0.008)                      | (0.009)                     | (0.012)                        | (0.012)                     |
| $\beta_{\text{agro-industry employees household}}$ | 0.045                        | 0.036                       | -0.031**                     | -0.022                      | 0.033                          | 0.037                       |
|  | (0.028)                      | (0.024)                     | (0.014)                      | (0.015)                     | (0.022)                        | (0.023)                     |

*Note:* Additional controls are included but not reported. See Table A2 in Annex.

Significant effects are indicated with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ . Robust standard errors in parentheses.

Source: Estimated from household survey data.

We recall that the measure of shocks used so far is based on the assumption that all specific shocks that occurred between the two survey rounds had an impact on the growth rate of household consumption only through household income changes. As such, household income changes might be the result of the combined effect of such shocks and the reaction of these shocks. As regards to the above, it could be argued that households face different types of shocks and that shocks experienced by agro-industry employee households are not persistent so that they are able to cope with, contrarily to the others type of households. However, the descriptive statistics in Table 1 show that in many cases there is no difference in terms of the nature of shocks experienced by the different types of households. This suggests that there is a difference in actual combination of strategies to deal with shocks between contracting households and households involved in agro-industrial employment. The livelihood strategies used by agro-industry employee households to deal with the shocks are more likely to be efficient than are those used by contracting households.

We explain our findings in two perspectives. The first plausible explanation is that agro-industry employee households are better endowed in human capital - which is less subject to shocks - which therefore is more likely to be used easily as coping mechanisms. On the contrary, contracting households have more access to physical capital but which is more subject to shocks. This physical capital is then less susceptible to be used efficiently by contracting households when shocks occur. The second explanation is that agriculture is intrinsically a risky activity due to variability in agro-climatic conditions and volatility in commodity markets which may lead to increased income uncertainty. Contract farming may change production and marketing risk for farmers and thereby affect their welfare. Contract farming may reduce or increase the risk that farmers' face (see Dedehouanou et al., 2013). In our case, households which had diversified towards export production through contracting farming, might both limit their portfolio of occupations and devoted mainly their livelihoods assets to this activity. This might explain whether contracting households seem still more vulnerable from shocks stemming from the labour market as they are unable to insure consumption against off-farm income fluctuation even when fully insured from farm income changes.

## **7. Conclusion and policy implications**

We used the consumption insurance framework to study whether households involved in high value supply chains are able to better insulate their consumption against shocks or income fluctuations. We found that there is a difference in the extent to which both types of participants in the supply chains insulate consumption from shocks. Households which are involved in the high value supply chain as producers are not able to better insure their total and food consumption against income shocks than their non-participating counterparts. In contrast, households involved in the high value supply chains as agro-industry employees are effectively able to better insure themselves. In fact all the households are able to cope with shocks from the product market while only households involved in agro-industry employment are more likely to insure their consumption from shocks from the labour market. The conclusion from this study is that while integration in international markets has a positive impact on economic development and poverty reduction it may not be sustainable enough to protect households—specifically contracting households—from vulnerability.

Our results suggest that policy makers should not focus only on poverty reduction issues when studying the welfare implication of rural households participating in high value agri-food supply chains. Complementary safety net programmes should be combined with programmes intending to increase the participation of households in contract farming. In addition, initiatives creating conditions conducive to dealing with risks for contracting households should also direct effort on off-farm activities given that labour market is found to be more vulnerable for contracting households. Our analysis on consumption insurance of households is based on two data points. We used the endogenous switching regression model to deal with the endogeneity and the selectivity issue entailed by the participation process. Yet the availability of panel data of more than two years could give more definitive conclusions about the vulnerability of households participating in high value agri-food supply chains.

## Notes

1. Maertens and Swinnen (2009) provide details of the high value agri-food supply chain process in Senegal.
2. In this study, consumption insurance is viewed interchangeably as consumption smoothing.
3. Note that while our data consists of panel data for 2007 and 2010, our empirical analysis was cross-sectional based on the difference between the two years.
4. Note that households that participated both as contracting and as agro-industry employees were excluded from the initial sample.
5. Households may self-select into contract farming or into agro-industrial employment based on their access to resources and their preferences. Exclusion or selection of potential contractors may be at the discretion of exporting companies because of the high transaction costs in sourcing from isolated farmers or their skills and their access to resources. Exclusion or selection of potential employees may be due to the long distance from employment location.
6. This form of covariate risk is used in other studies for the assessment of risk sharing in a given community (see, for example, Skoufias, 2007). It is probable that households use some specific insurance networks. We do not explicitly focus on this issue in our study because of data availability. We assumed that the within-village risk sharing mechanism is likely and used the village as insurance group.
7. Usual techniques such as the Heckit Model or the Instrumental Variables approach do not deal with full interaction.
8. In our case the benefit is, for example, a welfare improvement such as the consumption insurance.
9. The first difference-alike specification used in the ES model addresses further the issue of endogeneity as long as household behaviour in consumption insurance and the participation decision are both related to a household's unobserved time-invariant variables.



## References

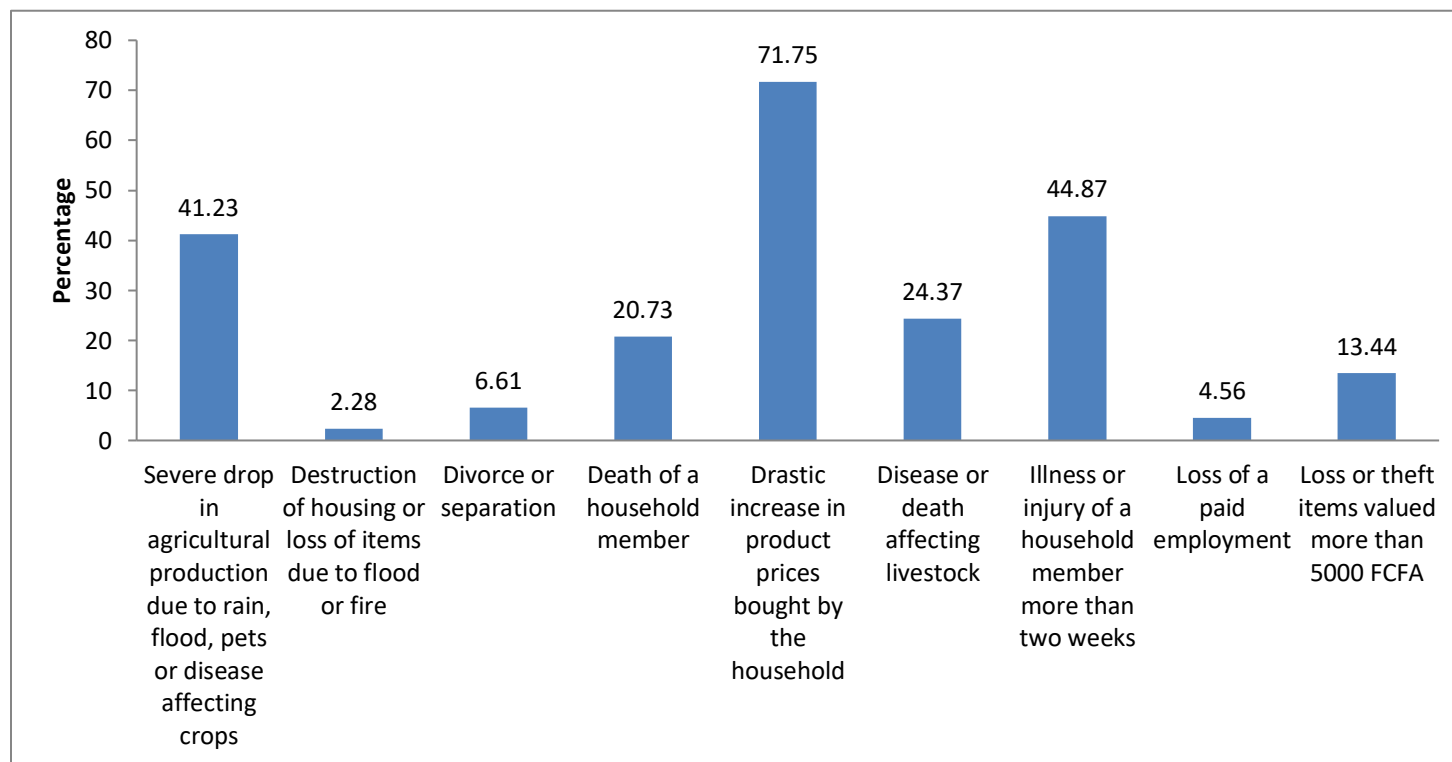
- Altonji, J. and A. Siow. 1987. "Testing the response of consumption to income changes with (noisy) panel data". *Quarterly Journal of Economics*, 102: 293–28.
- Amin, S., A. Rai, G. Topa. 2003. "Does microcredit reach the poor and vulnerable? Evidence from northern Bangladesh". *Journal of Development Economics*, 70(1): 59–82.
- Augier, P., M. Gasiorek and C. Lai Tong. 2005. "The Impact of rules of origin on trade flows". *Economic Policy*, 20(43): 567–623.
- Brenton, P. and M. Manchin. 2002. "Making the EU trade agreements work. The role of rules of origin". CEPS Working Document 183. Centre for European Policy Studies, Brussels.
- Chaudhuri, S. 2003. "Assessing vulnerability to poverty: concepts, empirical methods and illustrative examples". New York, Columbia University..
- Cochrane, J.H. 1991. "A simple test of consumption insurance". *Journal of Political Economy*, 99: 957–976.
- Dedehouanou, S.F.A., M. Maertens and J.F.M. Swinnen. 2013. "Does contracting make farmers happy? Evidence from Senegal". *Review of Income and Wealth*, 59: S138–60.
- De Weerd, J. S. Dercon. 2006. "Risk-sharing networks and insurance against illness". *Journal of Development Economics*, 81: 337–56.
- Dercon, S. 1996. "Risk, crop choice, and savings: Evidence from Tanzania". *Economic Development & Cultural Change*, 44(3): 485.
- Dolan, C. and J. Humphrey. 2000, "Governance and trade in fresh vegetables: The impact of UK supermarkets on the African horticulture industry". *Journal of Development Studies*, 37(2): 147–76.
- Fafchamps, M. and S. Lund. 2003. "Risk-sharing networks in rural Philippines". *Journal of Development Economics*, 71: 261–87.
- Gibbon, P. 2003. Value-chain governance, public regulation and entry barriers in the global fresh fruit and vegetable chain into the EU. *Development Policy Review*, 21(5–6): 615–25.
- Henson, S. and S. Jaffee. 2008. "Understanding developing country strategic responses to the enhancement of food safety standards". *World Economy*, 31(4): 548–68.
- Jacoby Hanan G. and Emmanuel Skoufias, 1998. "Testing Theories of Consumption Behavior Using Information on Aggregate Shocks: Income Seasonality and Rainfall in Rural India". *American Journal of Agricultural Economics*, Vol. 80, No. 1 (Feb., 1998), pp. 1-14
- Jalan, J. and M. Ravallion. 1999. "Are the poor less well insured? Evidence on vulnerability to income risk in rural China". *Journal of Development Economics*, 58(1): 61–81.
- Key, N. and D. Runsten. 1999. "Contract farming, smallholders, and rural development in Latin America: the organization of agroprocessing firms and the scale of outgrower production". *World Development*, 27: 381–401.
- Kherrallah, M. 2000. "Access of smallholder farmers to the fruits and vegetables market in Kenya". IFPRI Mimeo. International Food Policy Research Institute, Washington, D.C.
- Lanjouw, P. 2007. "Does the rural nonfarm economy contribute to poverty reduction?" In S. Haggblade, P. Hazell, and T. Reardon, eds., *Transforming the Rural Nonfarm*

- Economy: Opportunities and Threats in the Developing World*. . Baltimore: Johns Hopkins Press.
- Ligon, E. and L. Schechter. 2003. "Measuring vulnerability". *Economic Journal*, 113(486): C95–C102.
- Mace, B.J. 1991. "Full insurance in the presence of aggregate uncertainty". *Journal of Political Economy*, 99: 928–56.
- Maertens, M. and J.F.M. Swinnen. 2009. "Trade, standards, and poverty: Evidence from Senegal". *World Development*, 37(1): 161–78.
- Maertens, M. 2009. "Horticulture exports, agro-industrialization, and farm–nonfarm linkages with the smallholder farm sector: Evidence from Senegal". *Agricultural Economics*, 40(2): 219–29.
- Minot, N. and M. Ngigi. 2004. "Are horticultural exports a replicable success story? Evidence from Kenya and Côte d'Ivoire". EPTD/MTID Discussion Paper. International Food Policy Research Institute, Washington, D.C.
- Minten, B., L. Randrianarison and J. Swinnen. 2009. "Global retail chains and poor farmers: Evidence from Madagascar". *World Development*, 37(11): 1728– 41.
- Morduch, J. 2002. "Consumption smoothing across space testing theories of risk- sharing in the ICRISAT study region of South India". Discussion Paper No. 2002/55. UNU World Institute for Development Economics Research (UNU/WIDER).
- Morduch, J. 1995. "Income Smoothing and Consumption Smoothing". *The Journal of Economic Perspectives*, Vol. 9, No. 3 (Summer, 1995), pp. 103-114.
- Murata Akira and Suguru Miyazaki. 2014. "Ex-post risk management among rural Filipino farm households." Working paper n° 67. Japan International Cooperation Agency Research Institute, Tokyo, March.
- Porter, G. and K. Phillips-Howard. 1997. "Comparing contracts: An evaluation of contract farming schemes in Africa". *World Development*, 25(2): 227–38.
- Reardon, T. and C.B. Barrett. 2000. "Agroindustrialisation, globalization and international development: an overview of issues, patterns and determinants". *Agricultural Economics*, 23: 195–205.
- Reardon, T., J. Berdegue, C.B. Barrett and K. Stamoulis. 2007. "Household income diversification into rural non-farm activities". In S. Haggblade, P. Hazell and T. Reardon (eds.), *Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World*. Baltimore: Johns Hopkins Press.
- Reardon, T., J.-M. Codron, L. Busch, J. Bingen and C. Harris, 1999, "Global change in agrifood grades and standards: Agribusiness strategic responses in developing countries". *International Food & Agribusiness Management Review*, 2(3): 421– 35.
- RFAU/AOC. 2007. "Etude de cas sur le financement des agriculteurs et agricultrices urbains de la zone des Niayes (Sénégal)". Report. Réseau Francophone pour l'Agriculture Urbaine en Afrique de l'ouest eu centre (RFAU/AOC).
- Rosenzweig Mark R. and Hans P. Binswanger. 1993. "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments". *The Economic Journal*, Vol. 103, No. 416 (Jan., 1993), pp. 56-78.
- Skoufias, E. 2007. "Poverty alleviation and consumption insurance: Evidence from PROGRESA in Mexico". *The Journal of Socio-Economics* 36: 630–49.

- Skoufias, M. and A. Quisumbing. 2005. "Consumption insurance and vulnerability to poverty: A synthesis of the evidence from Bangladesh, Ethiopia, Mali, Mexico and Russia". *European Journal of Development Research*, 17(1): 24–58.
- Swinnen, J.F.M. (ed.) 2007. *Global supply chains. Standards and the poor*. Oxford: CABI Publishing.
- Townsend, R. 1995. "Consumption insurance: an evaluation of risk-bearing systems in low income economies". *Journal of Economic Perspectives*, 2: 83–102.
- Townsend, R. 1994. "Risk and insurance in Village India". *Econometrica*, 62(3): 539–91.
- Unnevehr, L.J. 2000. "Food safety issues and fresh food product exports from LDCs". *Agricultural Economics*, 23: 231–40.
- Warning, M. and N. Key. 2002. "The social performance and distributional impact of contract farming: An equilibrium analysis of the Arachide de Bouche Program in Senegal". *World Development*, 30: 255–63.

## Appendix

**Figure A1: Reported shocks experienced by the households between the first 2007 round and the last 2010 round.**



Source: Calculated from household surveys data.

**Table A1: Results from the ES model: Impact of changes in income on changes in consumption**

| Variables  | Non-participants | Participants | Selection equation |
|--|------------------|--------------|--------------------|
| Female head  | 0.075            | 0.260        | -0.211             |
| Age head   | 0.003            | 0.004        | 0.003              |
| Education head   | -0.028           | 0.131        | 0.226              |
| Change in household size                                 | -0.044***        | -0.009       | -0.032**           |
| Ethnicity (Wolof)  | 0.446***         | 0.172*       | 0.455***           |
| Dlog (income per capita)                                 | 0.003            | 0.052**      | 0.040              |
| Dlog (average village income per capita)                 | -0.013           | 0.074        | -0.159**           |
| Dlog (female labour)                                     |                  |              | 0.033              |
| Dlog(male labour)  |                  |              | 0.139***           |
| Distance of the exporter firms                           |                  |              | -0.006**           |
| Constant   | 0.388            | -0.542**     | -0.001             |
| Wald test of joint significance of instruments: $\chi^2$ |                  |              | 20.94***           |
| Wald test of independence of equations: $\chi^2$         |                  |              | 19.69***           |
| Log pseudolikelihood                                     |                  |              | -675.725           |
| Wald $\chi^2$  |                  |              | 106.36***          |
| Observations   | 439              | 439          | 439                |

Significant effects are indicated with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$   
Source: Estimated from household survey data.

**Table A2: Results from the ES model: impact of changes in income on changes in consumption by types of participants**

| Variables  | Non participants | Contracting households | Selection equation | Non-participants | Agro-industry employees households | Selection equation |
|--|------------------|------------------------|--------------------|------------------|------------------------------------|--------------------|
| Female head  | 0.072            | -0.020                 | -0.353             | 0.285            | 0.482*                             | 0.310              |
| Age head   | 0.004            | 0.005                  | 0.003              | 0.001            | -0.001                             | -0.000             |
| Education head   | -0.025           | -0.050                 | 0.296              | -0.042           | 0.283                              | 0.277              |
| Change in household size                                 | -0.043**         | -0.022                 | -0.026             | -0.047***        | -0.005                             | -0.058**           |
| Ethnicity (Wolof)  | 0.368***         | 0.284*                 | 0.186              | 0.431***         | 0.088                              | 0.733***           |
| Dlog (income per capita)                                 | 0.005            | 0.064**                | 0.045*             | 0.002            | 0.045                              | 0.064**            |
| Dlog (average village income per capita)                 | -0.009           | 0.049                  | -0.199**           | -0.025           | 0.126                              | -0.168             |
| Dlog (female labour)                                     |                  |                        | 0.045              |                  |                                    | 0.061              |
| Dlog(male labour)  |                  |                        | 0.150***           |                  |                                    | 0.117*             |
| Dummy if household has an irrigated system               |                  |                        | 0.260*             |                  |                                    |                    |
| Distance of the exporter firms                           |                  |                        |                    |                  |                                    | -0.030***          |
| Constant   | 0.343            | -0.959**               | -0.567             | 0.168            | -0.526                             | -0.681             |
| Wald test of joint significance of instruments: $\chi^2$ |                  |                        | 18.19***           |                  |                                    | 10.18**            |
| Wald test of independence of equations: $\chi^2$         |                  |                        | 10.06***           |                  |                                    | 4.39**             |
| Log pseudolikelihood                                     |                  |                        | -423.554           |                  |                                    | -324.169           |
| Wald $\chi^2$  |                  |                        | 60.87***           |                  |                                    | 69.45***           |
| Observations   | 269              | 269                    | 269                | 224              | 224                                | 224                |

Significant effects are indicated with \*\*\* p<0.01, \*\* p<0.05, \* p<0.10

Source: Estimated from household survey data.